Amended specification

Device for the storage of solid and/or liquid and/or gaseous objects.

CROSS-REFERENCE TO A RELATED APPLICATION

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BACKGROUND

The invention relates to a device for the storage of solid and/or liquid and/or gaseous objects. It makes it possible in particular for the state of packs such as blister packs or food packs to be automatically registered.

It is known in the health sector to use blister packs for storing and providing dosages of medicaments. To be able to appreciate the effect of medication that is administered, including possible side-effects, and to draw conclusions from this for further treatment, it is often important for the doctor carrying out the treatment to be able to establish precisely the amount of the administered medicament that has been taken and the time at which it was taken. For this purpose, there are known readers that register the state of the blister pack and - possibly via a remote connection - transmit the corresponding information to the doctor carrying out the treatment. Such monitoring capabilities are desired in particular in the area of home care.

To register the state of blister packs, the known readers are designed such that the blister pack to be examined is introduced essentially completely into the reader. The state of the blister packs is then determined either optically or electronically, in the latter case a simple interconnect being printed on the individual blisters, so that by applying two contacts in each case to a blister it can be detected whether or not the blister is still intact. A disadvantage here is that a large number of contacts have to be provided in the reader.

Known readers for blister packs are generally distinguished by a complex construction and high production costs. In addition, adaptation to respective dimensions of the blister packs to be examined is required.

Similar problems as occur when registering the state of blister packs also arise when registering the state of other packs, for example other medicine packs or food packs that are to be examined to ascertain whether they are intact.

The invention is accordingly based on the object of providing a device for the storage of solid and/or liquid and/or gaseous objects which, in conjunction with a reader, makes it possible for the state of the device to be registered in a simple and low-cost manner.

BRIEF DESCRIPTION

This object is achieved according to the invention by a device with the features of claim 1. Preferred and advantageous refinements of the invention are specified in the subclaims.

The solution achieving the object as provided by the invention is accordingly distinguished by the fact that the filling and/or emptying of the compartment triggers an electrically readable signal. The electrically readable signal allows the state of the device to be registered. In this case, not only removal of an object from a compartment but also filling or loading of a compartment with an object can be established or registered.

In a preferred refinement of the invention, it is provided that the compartment can be mechanically changed for removal of the object and/or for filling with the object,

and an electrically readable signal is generated when there is a mechanical change of the compartment. The mechanical change therefore leads directly to an electrically readable signal.

In a preferred development of this refinement, it is provided that an electrical data memory is integrated in the device. The electrical data memory has at least one memory cell which is respectively assigned to a compartment of the device and which adopts a different memory value when there is a mechanical change of the compartment. It is preferred for evaluation electronics for reading from the data memory to be additionally integrated in the device.

This preferred refinement is based on the idea of forming the device for the storage of solid and/or liquid and/or gaseous objects itself as a carrier of electrical functionality. In this case, a memory cell is respectively assigned to a compartment of the device which mechanically changes when an object is removed, so that the mechanical change of the compartment is reflected in a changed memory value of the respective memory cell. By reading from the memory cells by the evaluation electronics, the state of the individual compartments of the device, and consequently of the device as a whole, can be registered. The evaluation electronics may in this case be integrated directly in the substrate of the device or alternatively be formed on a separate carrier which is applied to the device.

The integration of the evaluation electronics in the device has the advantage that the intelligence for registering a change of state of the device is integrated in the device itself. This takes place in particular by the electrical data memory and the evaluation electronics being integrated in commercially available packs,

in particular by using polymer electronics. Realizing electronic functionalities in the device itself allows the intelligence of a reader to be reduced considerably and the size of a reader to be miniaturized to the size of nothing but a display, resulting in a considerable cost saving.

In this case, the reader now only needs to communicate with a standard interface of the evaluation electronics and it is no longer necessary to provide the reader with means which register the state of all the compartments of the reader. Rather, it is adequate just to provide a contact for serial data transmission. Furthermore, it is no longer necessary for the readers to accommodate completely the device of which the state is to be registered. This allows the readers to be made smaller and to be used in connection with a much greater variety of packs. Altogether, the automatic detection of the state of a device for the storage of solid and/or liquid and/or gaseous objects is made possible in a much simpler and low-cost way by the stated solution.

It is pointed out that, for the purposes of the present invention, a "compartment" is understood as meaning any region that can be spatially confined and allows an object to be at least partly accommodated or stored. In particular, compartments may be enclosed or only partly enclosed regions of a device. The device considered may have one or more compartments. For the purposes of the present invention, an "object" which is located in a compartment may be solid and/or liquid and/or gaseous. Objects are, for example, tablets or portions of food.

In a preferred refinement of the invention, a compartment respectively forms part of the associated memory cell. A mechanical change of the compartment accordingly leads directly to a changed memory value of the memory cell. It is preferred in this case for the compartment to have an interconnect which is part of the memory cell. The interconnect is destroyed when there is a mechanical change of the compartment, whereby the memory cell adopts a different value.

The memory cell and the associated compartment may, however, also be coupled in some other way. In another refinement, the compartment forms a capacitance, the capacitance changing when there is a mechanical change of the compartment, so that the memory cell then adopts a different value. It is likewise conceivable for the compartment to form an inductance and the inductance to change when there is a mechanical change of the compartment. In this case, the memory cell adopts a different memory value on the basis of the changed inductance. The memory cell may also have an oscillating circuit, which is destroyed or detuned when there is a mechanical change of the compartment, which in turn leads to a different memory value. The latter cases are appropriate alternatives to the electrical registration of a mechanical change of a compartment, in particular when an alternating voltage source is integrated in the device.

It should generally be noted that it is possible to provide both refinements of a memory cell in which the memory cell stores digital values, in particular digital voltage values (for example "ZERO" or "ONE"), and refinements of a memory cell in which the memory cell stores analog values. In a preferred refinement, only two values can be stored (for example "ZERO" or "ONE"), which correspond to the two states of the compartment ("filled" and "empty"

or "intact" and "opened").

The evaluation electronics have, for example, a shift register for reading from the data memory. The individual memory cells of the data memory in this case form parallel inputs of the shift register. The reading from the shift register takes place serially via a suitable interface. However, the evaluation of the data memory by a shift register is only given by way of example. A person skilled in the art appreciates that the reading of memory values of a data memory can be realized in a variety of ways.

The solution achieving the object as provided by the invention comprises both refinements in which a voltage source is integrated in the device and refinements in which a voltage source is not integrated. In the latter case, the energy for operating the data memory and the evaluation electronics is supplied externally, for instance by the reader. In the same way as the actual data transmission, this may take place with or without contacts.

In the case of a connection with contacts between the device and the reader, it is preferred for the evaluation electronics to have two terminal contacts for the voltage (the operating voltage Vdd and GROUND) and a terminal contact for serial data transmission. In addition, there may be a terminal contact for a timer. In the case of a contactless connection between the device and the reader, the energy is coupled in inductively or by an electromagnetic signal. The latter methods are provided in the case of information transmission on the basis of RFID (Radio Frequency Identification) and are known to a person skilled in the art.

In a development of the invention, it is provided that the evaluation electronics themselves have a timer and store the time at which a compartment was mechanically

changed. This makes it possible additionally to store the time of removal of a medicament or food from a compartment under consideration and establish this after the event. If corresponding intelligence is integrated in the evaluation electronics, it is preferred for the evaluation electronics to be formed as a separate chip with an integrated voltage source that is applied to the device, for example adhesively attached. Such a "high-performance" refinement of the evaluation electronics is expedient in particular in the case of high-value medicaments, for example genetic engineering medicaments. In this case, it is preferred for the chip to be formed as a silicon chip.

However, it is preferred for the memory cell and/or the interconnects and/or component evaluation electronics to be integrated directly in the substrate of the device. The memory cell is in this case formed as an inherent WOROM (WOROM = write once read-only memory) integrated in the substrate of the device. To this extent, a writing operation only takes place once, when a mechanical change of the compartment respectively under consideration leads on one occasion to a changed memory value of the memory cell assigned to a compartment.

In a preferred "low performance" refinement of the invention, the data memory and/or interconnects and/or components of the evaluation electronics are at least partly formed as elements of polymer electronics. In particular, the device has for this purpose an assembly of layers and at least one of the layers of the assembly is used for forming an electrical function. It is preferred in this case to provide that active and/or passive electrical components are integrated in the assembly of layers, such as transistors, diodes, capacitors, inductors or resistors as well as circuits formed from them. The data memory and the evaluation electronics or components of the data memory and of the

evaluation electronics can in this way be integrated at low cost directly in the substrate of the device for the storage of solid and/or liquid and/or gaseous objects. It is preferred for the integration to take place in the substrate of the pack that represents or has the device.

The formation of electronic circuits from plastic on or in a commercially available packaging film is known. In a way similar to newspaper printing, the film runs through a number of coating and structuring operations. Active or passive electronic components are thereby integrated in the individual layers of the film, so that electronic circuits can be formed in the film.

The materials necessary for realizing electronic circuits, that is to say semiconductors, insulators and interconnects, are respectively available as polymers or as low molecular weight compounds of an organic, inorganic or organometallic nature and as composites (organic, inorganic, organic/inorganic), so that the materials can be applied one after the other to different carrier materials in order to realize a desired electronic functionality. In particular, it is also possible to provide organic transistors, which - in a way similar to silicon-based transistors - are made up of a number of layers: substrate, gate electrode, gate insulator, source and drain contacts, organic semiconductors (for example pentazene or substituted oligothiophenes) and a protective passivation. It is also conceivable for hybrid organic/inorganic structures to be used and integrated in the substrate of the device or the substrate of the pack.

The integration of electrical functionality in

plastic films based on polymer electronics represents an extremely appropriate refinement of the teaching to integrate evaluation electronics for reading from a data memory together with the data memory in a device for the storage of solid and/or liquid and/or gaseous objects. However, it is only a preferred refinement. In principle, the data memory and the evaluation electronics may also be realized in some other way, as stated above.

In further preferred refinements, in the event that the substrate of the device has an aluminum layer, the electrical lines of the data memory or the evaluation electronics are formed by the aluminum layer itself, which for this purpose is correspondingly structured and after the structuring serves as an interconnect level. Alternatively, the interconnects may, for example, be realized with the aid of conducting organic compounds by being printed on. Suitable, for example, as organic compounds are carbon black, polystyrene sulfonic acid doped polyethylene dioxythiophene (PEDOT:PSS) or camphor sulfonic acid doped polyaniline.

It has already been pointed out that it is preferred for the device to represent or have a pack, the pack forming the compartments, and the data memory and the evaluation electronics being integrated in the substrate of the pack. The pack is, for example, a blister pack. However, the invention is also suitable for detecting the state of other packs, in particular for detecting the state of food packs. For example, the device may be a yogurt cup. Together with the aluminum lid, the yogurt cup in this case forms a memory cell, the memory value of the memory cell being changed when the conducting aluminum lid is pulled off, i.e. when there is a mechanical change of the yogurt cup.

The evaluation electronics are, for example, integrated in the plastic material of the cup.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is explained in more detail below on the basis of several exemplary embodiments with reference to the figures of the drawing.

Fig. 1 schematically shows a data memory and evaluation electronics of a device for the storage of solid and/or liquid and/or gaseous objects and also an associated reader.

Fig. 2 shows an arrangement according to Fig. 1, in which the interface of the evaluation electronics is formed as an interface with contacts.

Fig. 3 shows an arrangement according to Fig. 1, in which the interface of the evaluation electronics is formed as an RFID interface.

Fig. 4 shows an exemplary embodiment of the evaluation electronics of Figs 1 to 3, the evaluation electronics having a shift register.

Fig. 5 shows an exemplary embodiment of evaluation electronics according to Figs 1 to 4, the evaluation electronics being formed as a separate chip with an integrated timer function and voltage supply.

Fig. 6a shows in side view a number of blisters of a blister pack, which respectively form part of a memory cell.

Fig. 6b shows a plan view of the blister pack of Fig. 6a.

Fig.7 shows an exemplary embodiment of a memory cell.

Fig. 8 shows a blister pack with integrated memory cells and integrated evaluation electronics.

Fig. 1 shows a data memory 1 and evaluation electronics 2, which form a component part of a device for the storage of solid and/or liquid and/or gaseous objects.

The data memory 1 has a memory cell, which is assigned to a compartment 71 of the device for the storage of solid and/or liquid and/or gaseous objects. The compartment 71 serves for accommodating at least one object. For example, the compartment 71 is a blister of a blister pack. When a mechanical force F is exerted on the compartment for the purpose of removing the object contained therein, the compartment 71 is mechanically deformed or changed. This change leads to a changed memory value in the memory cell. For example, the memory value before removal of the object is logical zero and after removal of the object is logical one.

For reading the value from the data memory 1, the evaluation electronics 2 are provided, having an evaluation module 3 and an interface 4. The values of the data memory 1 registered by the evaluation module 3 can be transmitted via the interface 4 to an external reader 5. The transmission may take place with or without contacts. The reader 5 has a display 51, on which the information concerning the memory value of the data memory 1 or the corresponding information on the state of the device under consideration can be displayed. Since the evaluation electronics 2 are integrated in the device

for the storage of solid and/or liquid and/or gaseous objects, the reader 5 can be designed in a simple manner.

Fig. 2 shows a refinement of the device for the storage of solid and/or liquid and/or gaseous objects, in which a data transmission to a reader takes place with contacts. In the refinement of Fig. 2, the data memory 1 contains three memory cells 11, 12, 13, which are respectively assigned to a corresponding compartment (not separately represented). The evaluation module 3 reads the current values from the memory cells 11, 12, 13 and imparts this information to the interface 4a. The interface 4a has four standardized terminals. These terminals are a terminal for the operating voltage Vdd, a terminal for the reference potential GROUND, a terminal D for serial data transmission and a terminal for a clock. It is also possible to dispense with the latter. With the clock, the data transmission is synchronous, without the clock it is asynchronous.

In the exemplary embodiment of Fig. 3, a contactless interface 4a on the basis of the RFID standard is provided. The RFID interface 4a represents a transceiver (or a "tag"), which interacts with an RFID reader. For contactless communication, the RFID interface 4b has an antenna 4b'. Energy is coupled into the interface 4b inductively or by electromagnetic waves via the reader and is made available to the evaluation unit 2 and the data memory 1. With the aid of the energy coupled in, the current value of the memory cells 11, 12, 13 is registered and transmitted to the reader.

RFID interfaces may in this case be formed in a variety of ways. For example, it may also be provided that a voltage source is integrated in the RFID interface 4b or in the

evaluation electronics 2 (what is known as an active RFID transceiver). Since a person skilled in the art is familiar with contactless communication by RFID components, this is not discussed any further.

Fig. 4 shows a possible refinement of the evaluation module 3. In the exemplary embodiment represented, the evaluation module 3 has a shift register 31 with a multiplicity of cells 311, ... 31n. The output values of a multiplicity of memory cells 11, 12, 13 ... 1n are fed via parallel inputs E1, E2, E3, ... En to the individual cells 311, ... 31n of the shift register 31. The shift register 31 passes the information of the respective cell on to the following cell at the clock times. At the output A, the information of the individual data memories can be read in a serial mode.

The clock of the shift register 31 is prescribed by a timer CLOCK, it being possible for the timing signal to be externally supplied or for a timer to be integrated in the evaluation electronics.

Fig. 5 shows an exemplary embodiment of evaluation electronics 2 which are formed in a separate chip, which is applied to the device for the storage of solid and/or liquid and/or gaseous objects and is electrically connected to the data memory 1 of the device via suitable contacting points (not represented). The evaluation electronics 2 are formed, for example, on a silicon chip. A microprocessor 32 with RAM and ROM devices 33, 34 and also a clock generator (Clock) 35, a timer device (Timer) 37 and a voltage supply device 36 are provided. By providing a timer device 37, it is possible additionally to store the time at which a compartment is mechanically changed or the memory value of the associated memory cell 11, 12, 13 changes. The function of a timepiece is therefore provided. When monitoring the

state of the device, it is therefore possible also to register the time of removal of the respective object, such as for instance a tablet of a blister pack.

Figs 6a, 6b show a blister pack 7 with a multiplicity of blisters 71, 72, 73 in side view and in plan view as an example of a device for the storage of solid and/or liquid and/or gaseous objects. Each blister 71, 72, 73 represents part of a memory cell. For this purpose, an interconnect 104 is respectively integrated in the region 70 of the blister that can be pressed in. This interconnect is destroyed when the blister is pressed through. This leads to writing of the memory cell assigned to the respective blister 71, 72, 73, or to a change of the memory value.

Fig. 7 shows an exemplary embodiment of a memory cell or a memory element 11. According to the exemplary embodiment of Fig. 7, a line which is partly formed by the interconnect 104 of the compartment is connected between the terminals Ground 102 and the operating voltage Vdd 101. An output signal is provided at an output 103. A p-channel transistor 100, which is realized with preference by polymer electronics, limits the current, so that, when the interconnect 104 is closed, the potential at the output 103 is zero volts (logical zero). When the interconnect 104 is destroyed, on the other hand, the operating voltage Vdd (logical one) is present at the output 103.

The refinement of the memory cell represented in Fig. 7 is to be understood as given merely by way of example. Numerous other refinements of a memory cell are conceivable. For example, instead of a current-limiting transistor, a resistor may also be provided. For alternating current applications, capacitors and/or inductors may also be used.

Fig. 8 shows a memory cell with six blisters 71-76 and six assigned memory cells 11-16, which are formed for example as in Fig. 7. The outputs 103 of the memory cells are connected via electrical lines 8 to an evaluation module 3, which reads the content from the memory cells 71-76 and passes the data on to an interface 4 for transmission to a reader, the information transmission taking place for example without contacts by an RFID interface.

According to the exemplary embodiment of Fig. 8, not only the memory cells 11 to 16 but also the evaluation module 3 and the RFID module 4 are configured at least partly by polymer electronics. Used in this case as the carrier for the electrical lines 104, 8 is a correspondingly structured aluminum layer of the blister pack, which after structuring contains interconnects in a suitable way. The further components of the memory cells and of the evaluation electronics 3, 4, such as transistors and diodes, are integrated in further layers of the plastic material of the blister pack 7. In this case it is also preferred for the RFID interface 4 to be realized on a polymer basis.

Instead of an RFID interface 4, an interface with contacts, corresponding to the interface 4a of Fig. 2, may also be used.

After removal of the medicament contained in the respective blisters 71 to 76, the information on the change of the respective blister is read into the reading module 5 (cf. Fig. 1) and presented there or passed on. The reading module may in this case be used with a multiplicity of blister packs of different sizes and numbers of blisters. Commercially available RFID readers or else readers specially designed for blister packs may be used.

The invention is not restricted in its implementation to the exemplary embodiments presented above. Instead of blister packs, any other desired packs or devices for the storage of solid and/or liquid and/or gaseous objects may be used in connection with the invention. The compartments that can change mechanically when an object is removed are, for example, compartments of commercially available food packs. The invention then makes it possible after a delivery of food has been received to check quickly whether the packs of the individual foods have been damaged during transit.

In other refinements of the invention, the filling of a compartment is registered, an electrically readable signal being generated when a compartment is filled. The electrically readable signal is triggered in particular by a mechanical change of the compartment during the filling operation